Space Weather Technical Forecast

Issued on Saturday, 23 April 2022 at 01:22 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Moderate Solar activity expected with further M-class flares (R1/R2 Radio Blackouts) likely and a slight chance of X-class flares (R3 Radio Blackouts).

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Moderate with two M-flares; M3.4, peaking 22/1315 UTC and M1.1 flare peaking 22/0514 UTC, both from AR2993 (Dkc/Beta-Gamma-Delta). This forms a complex of sunspot regions in the northern centre disc with AR2994 (Ehi/Beta), however this sunspot has been more stable and showing signs of slow decline. There are six further region on the Earth-facing disc, five of which are across the northeast quadrant, with a further small region in the southwest. The regions are smaller, and also currently simpler, with no significant activity observed. No Earth-directed CMEs have been observed on available imagery during the last 24 hours.

Solar Wind / Geomagnetic Activity: The solar wind speed as observed by DSCOVR and ACE at L1 has persisted around 430-470km/s, with the density around average. The Interplanetary Magnetic Field strength (IMF) Bt, started moderate persisted at weak levels, below 6nT. The north-south component Bz oscillated between +6nT and -5nT. Phi angle was mainly positive throughout. Geomagnetic activity remained Quiet (Kp1-2).

Energetic Particles / Solar Radiation: The high energy proton flux (10 MeV) was at background levels throughout. The high energy electron flux (greater than 2MeV) has been at background to Moderate levels throughout, with the associated 24 hour fluence below the Active (1e8 integrated pfu) level. The 23/0000 UTC observation was 9.01e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar Activity is expected to be Moderate, with further M-flares, most likely from AR2993. There is a slight chance of this increasing to High due to an isolated X-class flare.

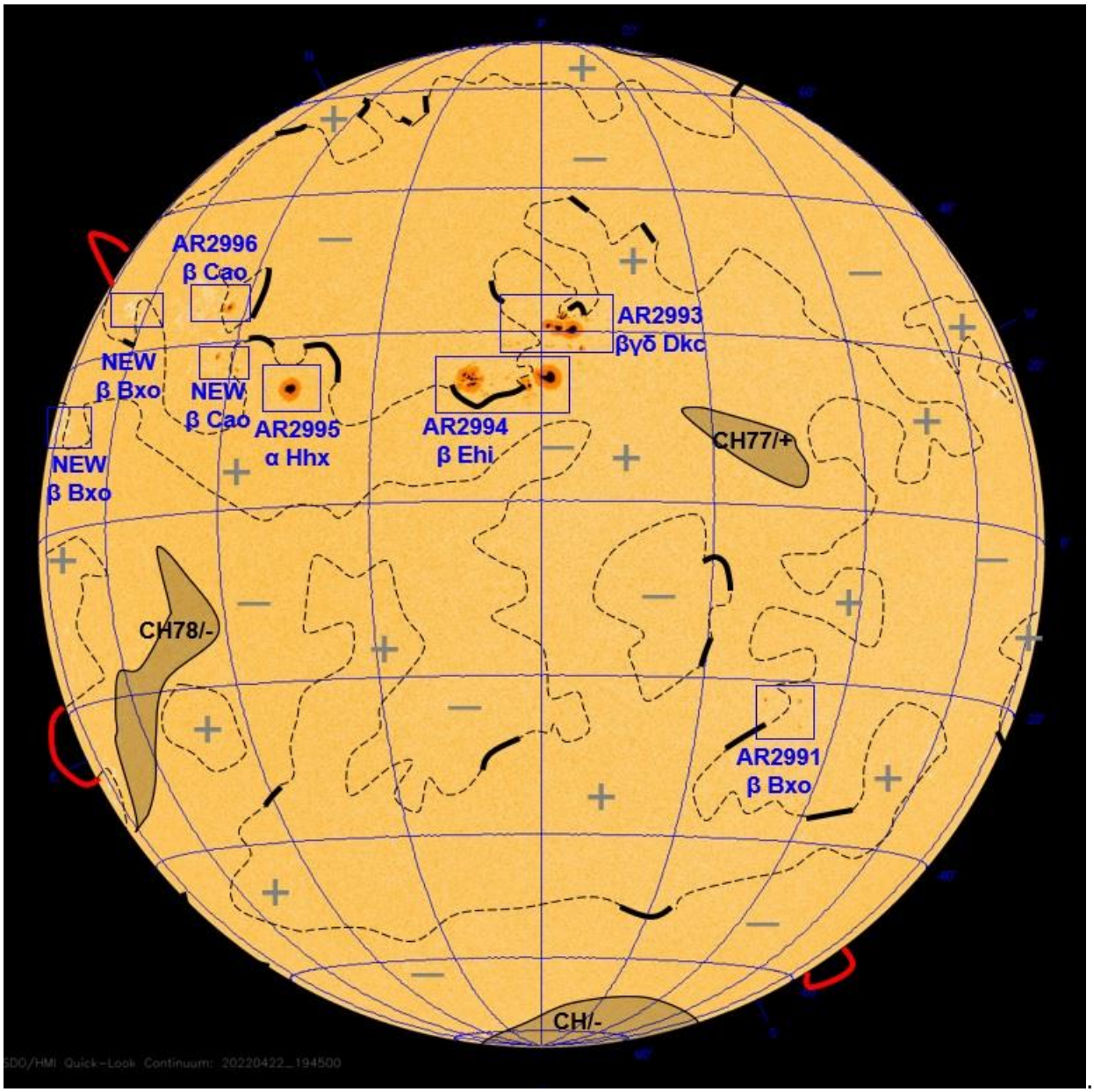
Solar Wind / Geomagnetic Activity: A CME which left the Sun on the 21st due to an M9.6 flare from AR2993 has a low chance to give a glancing interaction on the 24th. Otherwise, solar winds are forecast to ease day 1 (23rd) before likely becoming slightly enhanced day 2 (24th) due to the arrival of the fast wind of CH77. These elevated solar winds then easing day 3 (25th onward). Geomagnetic activity is forecast to be mostly Quiet with isolated Unsettled intervals. A spell of Unsettled to Active is possible with the arrival of the coronal hole fast wind, most likely day 2 (23rd or 24th). There is a slight chance of G1/Minor Storms, most likely if this is alongside any glancing CME arrival.

Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux is expected to be at Background levels, although there is a very gradually increasing risk as the more complex regions on the Earth-facing disc move onto and across the northwestern quadrant. The high energy electron flux (greater than 2MeV) is expected to be at mainly background levels. Electron fluence values are forecast to remain below the Active (1e8 integrated pfu) threshold.

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2022. All Rights Reserved.

Figure 1. Solar Analysis Valid 22/2000 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2022. All Rights Reserved.

Geomagnetic Storms:

A CME which left the Sun on the 21st due to an M9.6 flare from AR2993 is forecast to pass Earth orbit on day 2 (24th April), likely missing behind and to the north of Earth, but with a slight chance of a glancing interaction.

Current slightly elevated solar winds are likely to ease at first, but are also expected to become enhanced day 2 due to the arrival of the fast wind of CH77/+ which is a northern hemisphere feature. While persistence would suggest an earlier arrival, this feature is much reduced compared to the previous rotation, with an eastward displaced leading edge. Furthermore, the lack of response at STEREO A, whilst further south of solar equator than Earth suggests only a limited enhancement is likely. Consequently a day 2 arrival is considered more likely.

Geomagnetic activity is forecast to be mostly Quiet with isolated Unsettled intervals. A spell of Unsettled to Active is possible with the arrival of the coronal hole fast wind, most likely day 2 (23rd or 24th). There is a slight chance of a glancing interaction of the CME at the same time, giving a slight chance of G1/Minor Storms. Geomagnetic activity easing again day 3 (25th).

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	5	20	5	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
21/1245 UTC	Partial	M9.6 flare	18E 15N	420 km/s	24/1800 UTC +/- 9 hours	Very low confidence – likely missing, but chance of glance.

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2022. All Rights Reserved.

Figure 2: Enlil and ensemble Shows CME arrival, however delayed slightly over Enlil due to much stronger fast wind within the model compared to forecast.

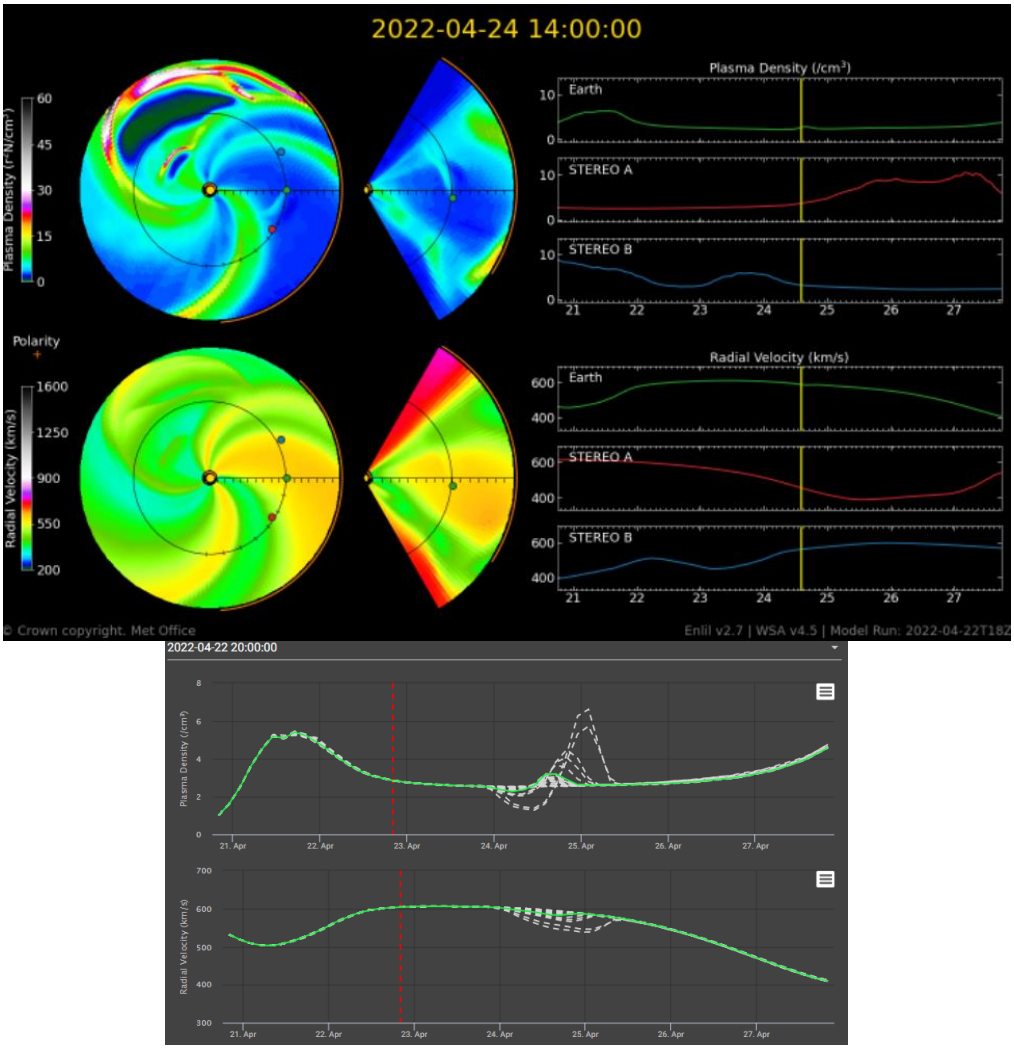
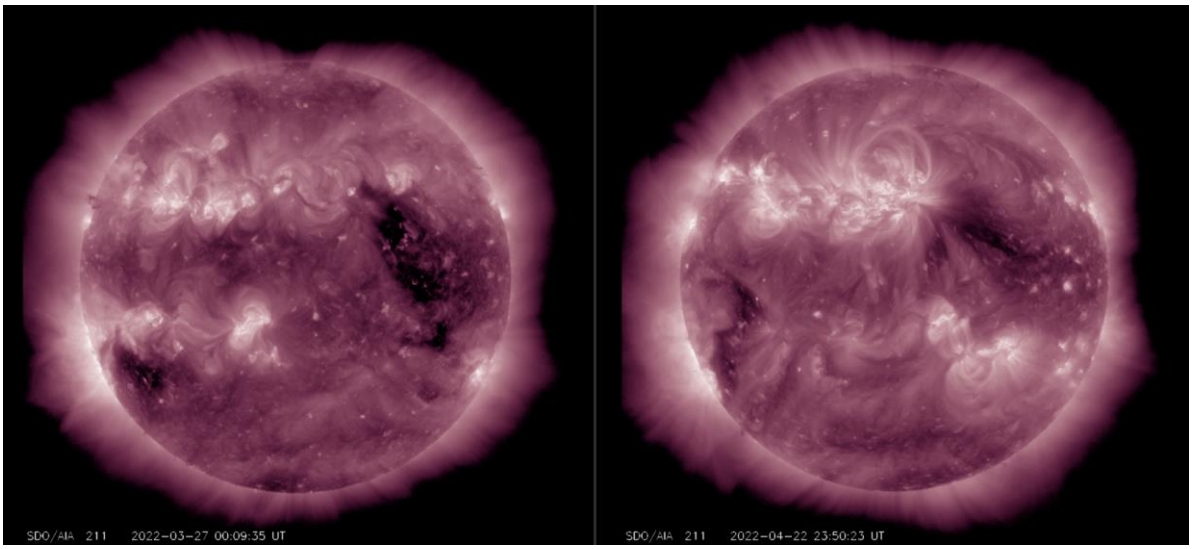


Figure 3: SDO aia-211 showing much reduced CH topography on this rotation (right) compared to last rotation (left)



Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2022. All Rights Reserved.

Radio Blackouts - X-Ray Flares:

Solar activity has persisted at Moderate with 2 M-class flares in the last 24 hours, both from AR2993 Dkc/Beta-gamma-delta, which has now moved beyond the central meridian and into the western hemisphere. This been reclassified to account for the dominate trailer being to the north of the main spot, and containing a very small but observable delta spot. This suggests increased instability of this spot, with magnetic shear likely across its field lines.

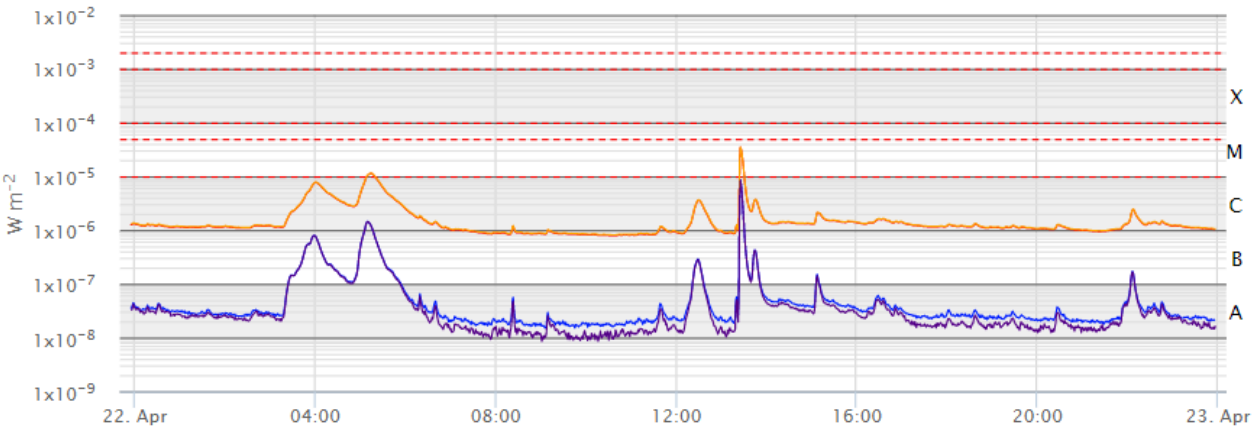
This region still forms a broad sunspot area alongside AR2994 Ehi/Beta although this region looks increasingly open, with its trailer gradually splitting. Despite this, the available flux across this entire area results in a likelihood of further M-class flares and a slight chance of X-flares. This risk is reduced very slightly day 2 as there is low confidence for the longevity of the current very small delta spot and any induced instability.

There are a total of eight sunspot regions on the disc, with five of these smaller and simpler regions following the two sunspot above across the northeast quadrant. Whilst these all aid to keep a background C-class flux level likely, with further C-flares, they have a much reduced chance of producing notable M-flares compared to the previously mentioned regions. Otherwise, there is one small sunspot on the southwest, showing signs of decay. There is also the likelihood of further regions to rotate onto the southeast disc, visible in STEREO A euvi-imagery and also visible in far-side products.

Overall, activity is forecast to be Moderate, with isolated M-flares and a slight chance of X-class (R3 radio blackouts).

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	80	70	70	70
Very Active	R3 to R5 X Class	No	20	15	15	15

Figure 4: GOES 16-17 X-ray flux



Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2022. All Rights Reserved.

Figure 5: SDO Intensitygram and Magnetogram of AR2993 and AR2994

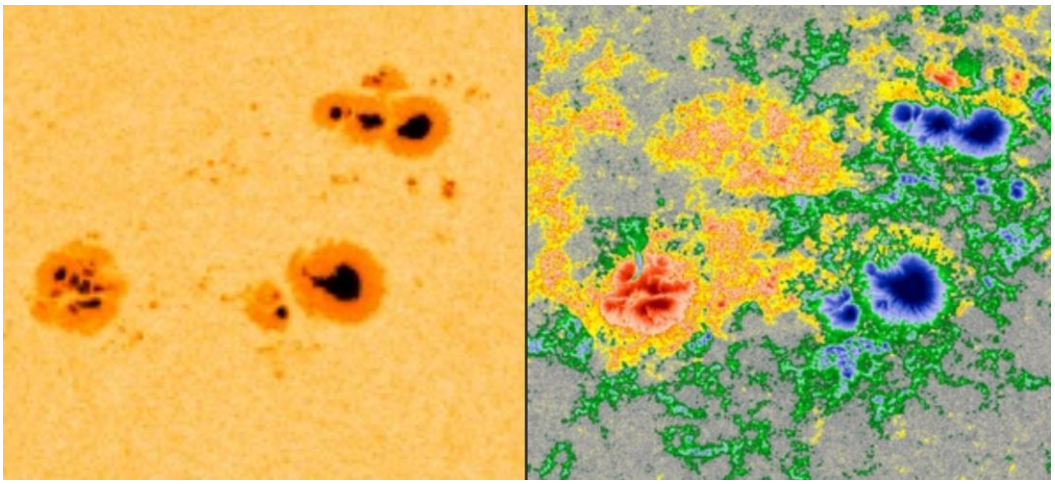
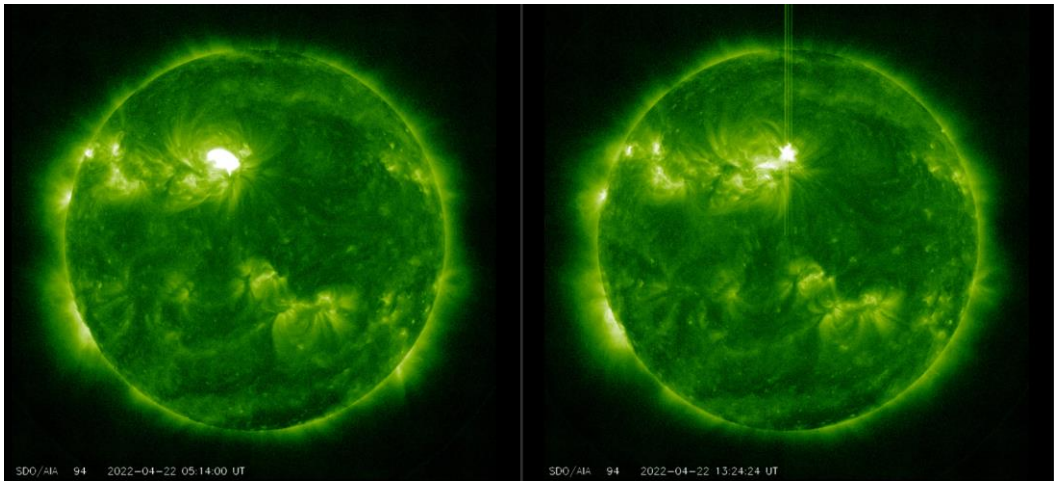


Figure 6: SDO aia-94 of the two observed M-flares flares



Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10 MeV) as measured by GOES-16 at GEO is at Background levels, and is expected remain so through the next four days. However AR2993 and AR2994 form a complex of sunspots across the central disc that are increasingly in a geoeffective position for proton enhancement should any proton rich flares occur. This gives a slight but increasing potential for solar radiation storms to occur at Earth.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	10	10	15	15
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2022. All Rights Reserved.

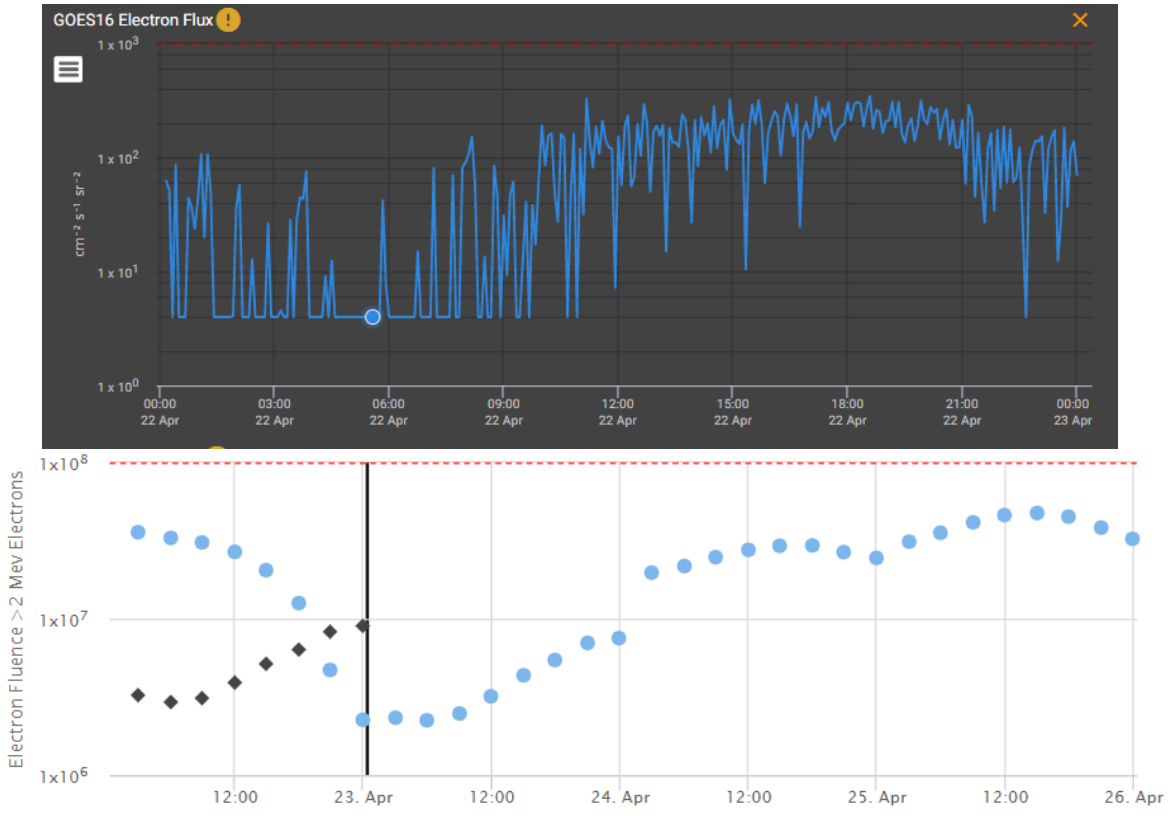
High Energy Electrons Event (≥ 2MeV):

The high energy electron flux (greater than 2MeV) as measured by GOES-16 at GEO is expected to be at mainly background to moderate levels throughout. A slight enhancement to the flux is possible day 3 (25th) onward, after the arrival of the fast wind of CH77 and any glancing CME interaction that occurs, however this is expected to remain below the Alert threshold (1000 pfu).

The associated 24 hour fluence values are expected to remain below the Active (1e8 integrated pfu) threshold, with REFM currently giving good guidance for the first 24 hours, however becomes unreliable beyond this due to a persistence component with the coronal hole topography noticeably different on this rotation.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	1	1	1
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 7: GOES-16 >2MeV Electron Flux and associated fluence with REFM.



Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2022. All Rights Reserved.